Practical Considerations

Beyond the philosophical issues associated, there are several tangible practical issues associated with structure sharing that the Hatfield Model ignores. Regarding aerial plant, currently accepted, industry-wide engineering practices dictate minimal use of aerial facilities. This design principal recognizes: 1) the higher whole-life costs (including maintenance) of the facilities, 2) the exposure of the aerial facilities to more and greater environmental hazard, and 3) the zoning requirements of many local governments regarding design aesthetics. Consequently, the assumption regarding the mix of aerial, buried and underground plant is untenable. While the model does permit adjustment of this mix, the selection of the defaults shown in the model reflects antiquated thinking about outside plant design. It also obviates the usefulness of the Southern California Joint Pole Committee cited in the supplementary Hatfield Model filing.[4]

Regarding manhole-conduit system use, there are several cable placement problems ignored by the Hatfield Model. For example, there is a significant problem raised in the size of the manhole specified in the model. The model should specify a precast manhole with standard dimensions of 6 feet X 12 feet X 7 feet (excluding the mid-section), as recommended in the *AT&T Outside Plant Engineering Handbook*. Instead, the model specifies a much smaller Type A handhole with dimensions 4 feet X 6 feet X 7 feet.[5]

A manhole with these dimensions does not provide the capacity suggested by the model as being available for sharing or lease. Indeed, it would be difficult for a manhole with these dimensions to accommodate multiple splices and cable entries as the number of

---

[4] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 21.

[5] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, Section 8. The sponsors of the model cite as support for this selection a publication called the National Construction Estimator, 44th edition, page 442.

cables and their sizes increase. As confirmed by the AT&T handbook, engineers should only use this manhole for "light, secondary conduit runs or buried cable runs."[6] This practice serves to reduce the cost of manholes in the model's calculation, and therefore understates the true cost of network construction. More significant to the present discussion, it precludes the volume of sharing assumed by the model.

Under certain circumstances, regulatory authorities or responsible outside plant planning design principles dictate the sharing of duct. In these cases, users must make substantial modifications to the model, including changes in the size and price of the manholes and in the number and cost of multiple ducts. Moreover, users would need to incorporate the costs attributable to "proving" the duct and to cable pulling in the duct. Neither cost is evident in the Hatfield Model.

The Hatfield Model does not properly apply additional cost burdens before assuming the split in costs associated with the conduit/direct buried/ aerial applications. There will be an increase in construction placement costs in most cases if trenches or other facilities are shared or jointly occupied. In most cases, a shared trench must be deeper and wider to accommodate the additional utilities that are participating in the shared or common trenching. This is a function of the requirements for minimum separation in horizontal and vertical planes mandated by the governing authorities.

To expand on this subject, the *AT&T Outside Plant Engineering Handbook* specifies: "**Joint trenching with power facilities should be employed only for distribution cables and service wires, not for feeder or trunk cables**" [emphasis in original publication].[7] The same document also specifies the minimum separation distances that en-

---

[6] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 8-35, Table: "Precast General Use Manholes".

[7] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 9-5.

gineers must maintain between power and telephone plant to ensure public safety and the integrity of the facilities. The separation distance is 12 inches in most cases. More importantly, however, higher voltage power lines must be placed at a greater depth (for example, 42 inches for voltages over 50,000), which will increase the cost of trenching substantially.[8] In addition, some municipalities, counties and parishes require additional protection such as concrete caps, concrete encasement, or steel casings for shared facility use.

Sample Calculation

In the calculation of the cost of support structures such as poles and conduit systems, the Hatfield Model first estimates the total cost of the structures. Based on its assumption that three users will share each structure, the model then allocates 33 percent of the total structure costs to the telephone network. Such an approach to cost identification leads to logical contradictions in many instances.

We observe such contradiction in the following example from the State of Florida. In the calculations of cable requirements for one Florida Census Block Group ("CBG"), the Hatfield Model specified the placement of five 4,200 pair copper feeder cables, one 1,800 pair copper feeder cable, and one fiber cable in one conduit. The model specifies that these cables will occupy only 1/3 of a single duct that costs just $1 per foot (exclusive of placement costs). The diameter of a 4,200 pair, 26 gauge air core copper cable (DUCTPIC® Bonded Stalpeth) is 3.35 inches. The diameter of a 1,800 pair, 24 gauge (as specified by the sponsors of the Hatfield Model) air core copper cable (DUCTPIC® Bonded Stalpeth) is 2.88 inches. The diameter of the fiber feeder cable would be at least one-half inch. Because the diameter of a duct is 4 inches, an engineer obviously will require more than one duct to design the network. Consequently, the duct

---

[8] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 9-6.

will have a material cost much higher than the cost per foot suggested by the model's calculations.

Summary

The principle of "least-cost" dictates that ELECs and ILECs model their networks with facilities of dimensions and capacities suitable for present service rather than future service. Therefore, an ELEC or ILEC probably would perform forward-looking new construction with "least cost" poles that power companies could not share because of the short pole height. In any event, the power and CATV companies probably would not share these "least cost" poles because their systems already exist. The shorter pole size also would mean that ELECs that chose to attach to ILEC-owned poles might encounter difficulty ensuring road clearances at mid-span.

Similarly, the ELECs or ILECs would perform the forward-looking new construction using "least cost" manholes and fully occupied ducts. Under these circumstances, users obviously will invoke the ability to modify default values during actual cost studies. However, use of these default values by the sponsors of the Hatfield Model will skew the results of analysis during public discussion. The Hatfield Model's input and structure assumptions are inappropriate to the constraints imposed by reality.

Furthermore, we believe that users of the Hatfield Model should give some consideration to issues of public safety and security. The model does provide for user intervention in the presumed sharing rates. We believe that engineers should use this feature for reasons other than economic considerations. For example, Pacific Bell does not share conduit with gas companies or power companies. The risk of explosion or inadvertent exposure of, or damage to, a power cable is too great to justify the financial savings.

Finally, the Expense Module appears to suggest that maintenance costs are part of the total shared structure costs. We believe this is a difficult assumption to sustain, because it implies that non-owners will incur some liability for the on-going expenses associated with maintaining the structures. It is difficult to conceive of such a relationship (as opposed to a lease or attachment arrangement). If the Expense Module does include provisions for sharing maintenance costs, we recommend reconsideration of the cost allocation for expenses.

Model

Introduction

It appears that the Hatfield Model contains no individual hidden cells. In general, however, the logic of the model is not readily apparent. The model embeds the logic within multiple worksheets and cells whose cross-references are unclear. Consequently, and in view of the time required to load and review the physical model, we have not attempted to perform a detailed analysis of the data flow within the model.[9] Moreover, we have performed no statistical significance testing on the constituent algorithms. Complicating these issues is the fact that the Hatfield Model requires (at least) two distinct models to run: the BCM-PLUS model and the Hatfield Model *per se*.

Nevertheless, we have evaluated constituents of the model and have identified certain flaws in the components of the model that appear to affect its overall utility. Most of these flaws are intrinsic to the model logic and do not appear to be changeable by the user.

Missing Inputs

There are several areas in the model that inappropriately preclude user input. In other words, the model does not consider all the units necessary to build a functioning telephone network. The cumulative effect of these omissions and related errors (for example, the model ignores many costs associated with the units that it does define) is to understate significantly the cost of constructing a network. These omissions result in the model being unsuitable to its stated purpose without major revisions.

---

[9] Using a 133 megahertz Pentium processor notebook equipped with 1.3 gigabytes of storage and 24 magabytes of memory, the model required 769 minutes to load and process the model and data for the state of Rhode Island, the smallest data set provided with the model. While we recognize that the model's designers recommend using a computer equipped with 128 megabytes of memory, we also recognize that design engineers will typically work with a system more closely approximating our test machine.

This is a particular problem for the design of the basic service loop. As currently configured, the Hatfield Model generates loop costs that are implausible and unreasonable by professional standards. Our engineering critique focuses on the problems associated with loop design. The remainder of this section considers other significant omissions from the Hatfield Model.

Construction Equipment

The Hatfield Model does not appear to make any provisions for vehicles, buildings, tools, equipment and similar network construction costs, as opposed to system operation and maintenance costs. If confirmed, this would have a significant impact on the cost of network construction. For example, fusion splicing equipment costs $45,000 or more per unit and optical time domain reflectometers ("OTDR") cost $15,000 or more per unit. Given the production capacity of these devices, these specific equipment costs will be particularly significant if the ELECs or ILECs attempt to build the network within the time frames implicitly assumed by the Hatfield Model. Similar costs appear in the Expense Module, but it is unclear if these are for maintenance or original construction. This is of particular importance if structure sharing is to recover the costs of operation as well as construction.

The Hatfield Model excludes the cost of Operational Support Systems ("OSS"). The true cost of a network must include the cost of numerous support systems, including switching software systems and their associated routing tables and data bases. Other functions for which an operating company must develop and use support systems include the following:

- customer care
- job management
- alarm management
- network management
- circuit management
- account management
- work force management
- network distribution mapping
- inventory
- charging and billing systems

- fault management
- materials management

The costs of these systems, which we estimate to be approximately five to eight percent of the network construction costs, should be included in the cost of building a network. It is unclear from the model's documentation if the model considers these costs only as expenses of operation.

The Hatfield Model makes several questionable assumptions regarding demand and system usage. For example, the Hatfield Model assumes a very high average amount of traffic that, in our opinion, is unlikely, particularly in a competitive environment where multiple service providers share the traffic. The Hatfield Model also assumes an excessive amount of directly trunked traffic, with only 20 percent of all traffic assumed to go through a tandem. We recommend review of these issues in future revisions of the model.

The Hatfield Model assumes a square CBG with a uniform distribution of households. The model attempts to lessen the impact of this unrealistic assumption by placing a Serving Area Interface ("SAI") farther into the CBG than is customary, a distance equal to one quarter of the length of one side of the CBG. However, this is equally unrealistic: the designed distribution cable lengths remain extremely long because the model assumes that each CBG contains only one SAI. In reality, design engineers may place many SAIs or cross-connects within large CBGs to reduce the high cost of distribution facilities. The model does not accommodate this problem, which we discuss in detail elsewhere in this evaluation.

Cost

The Hatfield Model uses a multiplier factor in its pricing calculations of the total cost of cable placement. The model uses this multiplier to incorporate the cost of materials and the cost of installation. However, there is some question as to the validity of this approach to cost identification. Indeed, the sponsors of the Hatfield Model criticized the use of this approach in the original BCM, observing that: "The effect of this multiplier ... which is itself computed based on unviewable input assumptions ... was to understate the investment."[10] We expect the team that is performing an economic evaluation of the model will review this issue in greater detail.

The Hatfield Model does not appear to consider the costs and design of Digital Cross-Connects ("DSX"). We consider this to be a significant omission because it indicates a lack of forward looking thinking in design. This omission constitutes evidence of, among other problems, the failure of the model's designers to consider the use of Synchronous Optical NETwork ("SONET") design principles for construction of the feeder portion of the network. Given the "green fields" approach advocated by the Joint Board, this is a particularly peculiar assumption that we consider in the conclusion of this review.

Logic

The Hatfield Model contains unreasonable, unrealistic, and decidedly not "forward looking" assumptions concerning the relative mix of aerial, buried, and underground facilities. For example, the model assumes that 65 percent of all facilities will be aerial in areas with population densities greater than 2,550 households per square mile. There are numerous contemporary engineering considerations that dictate use of underground or buried plant in preference to aerial plant in such areas. Moreover, many, if not most, cities and towns with population densities of this magnitude now require the placement of "out of sight" (underground or buried) facilities.

In other words, the mix as shown for the distribution plant is unbalanced and impractical. The current model shows distribution levels at the density mix of 850 - 2550+ dropping to

[10] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), August 16, 1997, page 7.

40% from a 50 % level and then increasing to a mix of 65% at the density level of 2550+. The mix as shown for feeder is more appropriate for both feeder and distribution. It is our opinion that the model should use, as initial default assumptions, the following values:

Density	Aerial	Buried	Underground
850 - 2550	15%	15%	70%
2550+	10%	20%	70%

Engineering

Cable

The Hatfield Model default value for the distance from the central office for the transition from copper cable to fiber cable is 9,000 feet. The sponsors of the Hatfield Model criticized this value in numerous hearings related to competing models. Nevertheless, the designers retained this value -- inappropriately -- in the model.

A design that is both forward looking and "least cost" approach must examine and integrate not only initial costs but also at least short term (three to five years) operating and perhaps whole life costs. Under these circumstances, and considering sound engineering design practices, it may be most appropriate to use fiber technology in all feeder plant design. The Hatfield Model specifies installed costs for 4,200 pair copper cable of $73.54 per foot. In terms of capacity, this is substantially more than the installed costs of $3.50 per foot for 24 fiber cable. The cost savings from placing all fiber feeder would support the installation of the necessary electronics at the COs and the remote terminals. The reduction in copper feeder costs would allow commensurate increases in copper plant distribution utilization.

In earlier versions of the Hatfield Model, the cost tables for copper cable included splicing costs. The current version of the Hatfield Model makes no reference in its inputs and assumptions to any splicing costs. If the copper cable costs include the cost of splicing, then clarification of the cost tables is necessary because they would appear to understate the actual costs.

The Hatfield Model does not include provisions for small cable sizes for copper feeder and distribution cables. This will prove to be a problem for many small and medium size operating companies that will be sizing distribution systems in more rural areas where 12 pair copper cable and 18 pair copper cable are economical and rational choices for system design. (This would not be an issue with fiber feeder, which would reduce the impact on transmission quality in the copper distribution portion of the loop.)

The model makes no provision for changes in gauge in the distribution system, an extraordinary weakness given the extra long loops they design with the model. Similarly, the model makes no provision for loading these extraordinarily long loops.

Carrier

The Hatfield Model uses population density groups to design and size Digital Loop Carrier ("DLC"). This methodology is likely to yield inconsistencies in design.[11]

The Hatfield Model does not include tables for DLC cabinets for Advanced Fibre Communication ("AFC") and Subscriber Loop Carrier ("SLC") 2000 equipment. The single maximum line capacity per AFC terminal in the Hatfield Model's Convergence Module does not match the capacity of any currently manufactured AFC cabinet. AFC cabinets are available in 48, 120, 240, and 672 line sizes. The SLC 2000 cabinet capacity of 672 lines shown is the smallest SLC 2000 cabinet available, not the largest as the table indicates. SLC terminal sizes are 672 lines, 1,334 lines, and 2,016 lines.

The Hatfield Model does not correctly calculate the number of fibers required to carry the SLC 2000 DLC to its correct maximum capacity. In the Main Logic sheet of the Hatfield Model Loop Master module, the model assigns 4 fibers to each CBG regardless of the number of lines served in that CBG. It does not design SLC terminals that share fibers to a maximum capacity of 2,016 as the documentation states. While not a fatal network flaw, this does provide evidence of poor design.

---

[11] Susan M. Baldwin and Lee L. Selwyn, "Continuing Evaluation of Cost Proxy Models for Sizing the Universal Service Fund: Analysis of the Similarities and Differences Between the Hatfield Model and the BCM2," Economics and Technology, Inc., October 1996, p. 73.

The model understates AFC equipment costs substantially. One reason is that the model does not include Local Exchange Terminal ("LET") costs. More generally, DLC costs do not include the costs for Central Office Terminals ("COT") or Fiber Optic Terminals ("FOT"). If fiber cable serves the DLC, the system will require at least one such device to convert optical signals to electrical signals. The model also understates DLC costs due to the exclusion of costs for the site, housing, and power supplies for these devices.

Conduit

The Hatfield Model appears to assume the placement of only one duct. However, the model also assumes the placement of a larger (variable) number of cables in that single duct. In general, in the feeder network, multiple copper cables cannot share a single duct. A 4,200 pair, 26 gauge air core copper cable is 3.35 inches, while the standard duct diameter is 4 inches. A filled 3,600 pair cable is 3.75 inches in diameter. Only one of either such cable can occupy a given duct.

Even with a design plan that utilizes fiber cabling for the feeder system, a conduit and manhole system would require a minimum of a four-way duct system to be both effective and efficient. This becomes even more important when tabled with the supposed planning of a shared or common trenching system. Only in the case of fiber cables, which have a substantially smaller diameter than copper cables, could construction workers place multiple cables in a single duct in a feeder network. However, if the company places a single fiber cable in a single duct, it is not possible to place an additional cable later because of the twist (curl) imparted to the cable from its storage and transport on a reel. To place multiple cables in a single duct, the engineer must design using one of three methods.

The first option is to place all cables (up to four or five, depending on their diameters) in the duct simultaneously. Although this may be an option with telephone cables, it is unlikely that safety regulations will allow placement of power cables in the same duct as telephone cables. In any event, the power and CATV utilities already have facilities in service and do not need to share duct. We judge this option inappropriate based on its unreasonable assumptions regarding construction coordination. Moreover, laborers could not place multiple copper cables in the duct in equal numbers due to the larger diameter of the cable.

The second option is to use special purpose duct equipped with multiple, preformed innerducts. Up to seven fiber optic cables could be placed in the most advanced such preformed duct that is currently available. We judge this option inappropriate based on its violation of the directive that "least cost" technology be used. Moreover, we could not place copper cables in the preformed innerducts due to the cables' larger diameter.

The third option would be to place up to four innerducts inside a 4 inch diameter duct and pull cables into the innerduct. We judge this option inappropriate based on its violation of the directive that least cost technology be used. Again, we could not place copper cables in the preformed innerducts due to the larger diameter of the cable.

Design

Quality of service parameters are dictated by all relevant state authorities. Among the most significant, relevant quality of service parameters is the requirement for the provision of service within some time frames. System designs must comply and any reasonable engineering model must be adaptable to this requirement. It does not appear that the Hatfield Model satisfies this demand for flexibility in scheduling service.

In their supplementary filing, the sponsors note that the model provides for the placement of optical repeaters at 41 mile intervals for interoffice service.[12] They assert that a design engineer would place such repeaters at central offices located along the interoffice route. This is a peculiar and untenable assumption presumably made to avoid the true costs of providing shelters or housings for the equipment.

The assertion that "there is normally an appropriate wire center location along the route to provide for this equipment installation" is spurious and misleading. They must still provide for land costs, floor space, equipment racks, building entrance, power, battery backup and similar site costs even if they placed the equipment in this suspicously convenient intervening wire center building.

The Hatfield Model assumes that an increase in cable length of 20 percent will compensate adequately for hard rock conditions during construction. The model's assumption, as explicated by the sponsors, is that: "The typical response to hard rock conditions is not to blast away the rock for telecommunications cable, but simply to route cable around those conditions where rock is at a depth of one foot or less."[13]

This is unrealistic and simplistic. Without reviewing the merits of "blasting," which may indeed be required in certain restricted mountainous rights-of-way, it is quite likely that construction will require preparatory work, such as pre-ripping or other geologic condition-specific placement methods, such as rock sawing or rock wheeling. The physical environment may well dictate use of techniques, which often are reasonable, sensible and rational engineering practice even if not mandatory Engineers cannot in every case "simply ... route cable around those conditions," particularly in built-up areas.

---

[12] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, miscellaneous input tables.

[13] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 23.

The Hatfield Model considers differences in population density by assigning a fixed number of distribution lines to areas of given population densities. The is an inappropriate methodology given the uneven pattern of human settlement, particularly in low and medium density areas. It would be preferable to use the average lot size in each CBG, combined with the number of households, to spread the distribution legs.

The Hatfield Model only permits network design with one SAI per CBG. Existing allocation areas, which in urban areas would be comparable in size to a CBG, often contain two or more SAIs, at about 3,000 pairs to 3,600 pairs per SAI. This limitation will make the design unreasonable and inadequate.

The Hatfield Model does not handle situations in which multiple wire centers serve a given CBG.

The Hatfield Model assumes the application of traditional feeder-distribution (dendritic) design principles. It does not appear possible to incorporate contemporary SONET fiber ring topologies in the feeder network, although the sponsors of the model assert that interoffice trunks run on SONET.

In their supplementary filing, the sponsors of the Hatfield Model stated that: "Extensive use of fiber-fed Integrated Digital Loop Carrier (DLC) in the feeder, with its attendant 0 dB loss at the Remote Terminal point, provides for a robust feeder facility." [14] How do they achieve 0 dB loss? This accomplishment would constitute a significant advance over current technology unless the designers are assuming signal regeneration between the central office and the remote terminal. Because no costs are specified for such regeneration, we believe the zero loss argument is spurious.

---

[14] "AT&T and MCI Submission on the Hatfield Proxy Model," (*Ex Parte* Presentation - Proxy Cost Model Questions, CC Docket 96-45), January 7, 1997, page 19.

After exceeding the capacity of a cable, the Hatfield Model automatically selects the next larger cable size, rather than selecting a second cable. This is not sound engineering and certainly is not least cost engineering. This will be most significant at the 2,400 breakpoint, where there is also a default transition in wire gauge from 24 gauge to 26 gauge. This could significantly impact the transmission network.

Drops

The Hatfield Model assumes a standard cost for terminals and drops. In reality, these costs vary greatly between zones of differing population density. Within more densely populated areas, where subscribers concentrate closer together, the design engineer can spread installation costs over a larger number of subscribers, particularly when pre-wiring sub-divisions.

In addition, equipment costs vary with population density. For example, the installed cost of a buried terminal is approximately $450 and the maximum allowable distance for a buried service drop is 900 feet from the terminal to a Network Interface Device ("NID"). In rural areas, families may reside more than 900 feet from a terminal, thus requiring one terminal per household or an average cost of $450 per household. In urban or suburban areas, 5 or 6 households may reside within a terminal's range, resulting in an average terminal cost of $75 per household.

The Hatfield Model uses fixed, idiosyncratic costs of questionable veracity (for example, the costs reported in the New Hampshire cost study for drops and Network Interface Devices). The price specified for a Network Interface Device -- $30 -- is too low by at least 20 percent. The Hatfield Model specified a cost per line for a terminal and splice of $35. This cost also is too low by at least 20 percent. Finally, the Hatfield Model specified a price for a house drop: of $40, which also is too low by at least 20 percent

Finally, the Hatfield Model does not distinguish between drop types or allow for differences in drop length.

Interoffice/Inter-Exchange

The Hatfield Model assumes all interoffice traffic travels over 24 strand fiber (equipped with OC-12 electronics to provide 12 DS3s). This assumption, which may be a function of the model's emphasis on large carriers, results in an over design of the capacity for low density area routes. Moreover, it skews their associated switch costs. For example, the model understates FOT costs for interoffice facilities significantly.

Land

We suspect that the Hatfield Model misstates land costs. The costs for land for the smaller sites appear to reflect the cost for rooms, which assumes existing facilities. This may or may not be reasonable in the rural areas.

Loop

Besides many unrealistic input values, the Hatfield Model includes loop design errors and engineering assumption cost mismatches that result in meaningless output cost levels. The model produces designs that either do not reach many of the subscriber locations or reach them with a pair of wires that cannot produce a dial tone. Moreover, the designs the model produces do not comply with a least one sponsor's specifications for resisteance design.[15]

The Hatfield Model incorporates a module, termed the Convergence Module.. This module incorporates design principles that reflect an increase in the number of distribu-

[15] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, especially "Section 5 - Transmission" pages 5-1 to 5-35.

tion cables within the CBG in the highest density groups and a reduction in the lowest density group. The density group of 0-5 households per square mile has only two distribution cables that are a multiple of 0.625 of the length of the side of the assumed (square) CBG area in length. These cables cannot possibly reach the subscriber locations unless the totally arbitrary assumption that all households reside very close to the CBG centroid should prove to be the case. In this respect, the Hatfield Model perpetuates a methodology that many engineers criticized as a serious flaw of the original BCM.

The Hatfield Model does not include adjustments to the distribution area to prohibit the placement of cable in unoccupied areas.

The Hatfield Model does not include a complete engineering design of the plant facilities within each CBG. The model does not incorporate the extension of feeder to an appropriate number of SAIs. In high population density areas, the model does not provide for a capacity driven, lower cost fiber alternative. The model also does not recognize that there is a high likelihood of conduit congestion in such high density areas. The model should invoke the economies of replacing copper with fiber instead of placing relief conduit.

There are a number of serious flaws that make at least the loop portion of the model unusable. The design process will produce many loops that physically will not work. Incorrect loop engineering assumptions preclude many of the subscribers from being able to have a basic 2 wire circuit with dial tone. Costing has either missing units or greatly understated unit costs. The Hatfield Model uses one set of cable costs yet is attempting to put large size cables in conduit while at the same time designing untreated copper loops that exceed 18,000 feet or even 37,236 feet in Florida. The 4,200 pair cable that the Hatfield Model places must be 26 gauge to fit in conduit. The length of loops used in the Hatfield Model design require 22 and 19 gauge hence an entirely different set of cable costs but there is no provision for copper pairs of those gauges in the design.

The 18,000 foot (and longer) loops require load coils which in turn preclude such services as higher speed modem links, ISDN, and the use of carrier frequencies to carry T-1/DS-1 type services to the customer. Without all the long loop design cost adjustments such as gauge changes, loading, and loop amplifiers, the Hatfield Model has significantly under designed the loop.[16]

Of serious concern is one change from the original BCM that Hatfield Model incorporates in calculating the transition point from fiber cable to copper cable. The Hatfield Model measures the length of feeder cable and compares it to a 9,000 foot test. The model uses copper cable whenever the length of the feeder route is less than 9,000 feet.

However, unlike the original BCM, the Hatfield Model ignores the length of copper cable in the distribution. The result is that the Hatfield Model continues to place copper for loop distances that exceed the working limits of an untreated copper loop. Loop design requires that different gauge cables or other alternatives be used but the Hatfield Model does not permit changes in gauge for this purpose.

This flaw yields results in untreated copper loop lengths behind the fiber terminal that are much longer than the 18,000 feet limit (in one case 99,868 feet long). Such loops would not function unless the engineer uses 19 gauge copper, load coils, and line amplifiers. There are many more in the data with distribution lengths well beyond an acceptable 1,500 ohm resistance design maximum.

The total length of distribution cable placed by the model is insufficient to reach all subscribers. The Hatfield Model assumes a square distribution area in its calculations. It proposes serving this area with a number of cables that are 5/8 of the length of the side

---

[16] *Outside Plant Engineering Handbook*, January, 1990, AT&T Document Development Organization, Winston-Salem, North Carolina, page 5-13 and following.

of the square (3/4 of the length if rock is present within one foot of the surface or if soil is difficult).

In the model calculations, this results in very large areas being served by 2 cables that only go 5/8 of a side. Test calculations have yielded untenable designs in several cases. For example, it is not possible for 2 cables that are 5/8 of a side to serve, in one case, 915 square miles with cables just under 100,000 feet in length. In another example calculation, the design specified serving 824 square miles with cables approximately 94,700 feet in length. In this case, substantial amounts of cable, structure, and placement costs are omitted from the calculated costs of placement.

Manhole

It appears that the method of designing underground systems will result in one less manhole than required for every system.

The Hatfield Model makes no provision for manholes in the distribution system. Manhole spacings in the distribution system should default to a shorter distance than manhole spacings in the feeder network because the distribution manholes serve smaller areas.

In more densely populated areas, manhole costs in the feeder network should be almost twice the $3,000 specified by the Hatfield Model. The $3,000 corresponds to purchase and placement of a small Type A handhole (4 feet X 6 feet X 7 feet) which is only sufficient and appropriate for feeder networks in less densely populated areas and for some distribution areas. The full-sized manhole required by the model's proposed networks would caost approximately $3,000 for materials and approximately $2,000 (or more) for placement.

Plausibility

The model apparently incorporates no provision for growth, presumably because of the "green field" approach dictated by the forward-looking cost assumption. However, sound engineering principles and least total cost economic planning principles dictate the assumption of some growth and the design of a distribution system that will accommodate ultimate demand. This is particularly compelling in view of the expected growth in demand for services that the Joint Board currently defines as "unsupported".

The Hatfield Model assumes that the ELEC or ILEC will build this network instantaneously. This, of course, is an unreasonable assumption. This is more than a philosophical problem. The assumption precludes satisfying the model's expectations related to joint construction and structure sharing, certainly for buried placement and probably for many underground placements.

The Hatfield Model assumes that the ELEC or the ILEC will build the local network to satisfy a perfectly known demand. Consequently, the model does not appear to include any break down of costs to reflect variable construction quantities. This makes any attempt to compare the specified unit prices with professional experience very difficult.

Poles

It appears that the method of specifying span lengths and distances, hence, the number of poles, will result in one less pole than required for every pole line. The Hatfield Model formula for calculating the numbers of required poles divides the total aerial plant distance by a span length of 150 feet and rounds up to the nearest whole number. For example, if a pole line includes just one aerial span that is 125 feet, the Hatfield Model will calculate the need for just one pole. If the pole line is 290 feet, the Hatfield Model will calculate the need for two poles, instead of the three poles that the pole line actual requires.

This will be a particular problem in areas where the average length of the spans differs from the assumed 150 feet. In those areas, it is insufficient simply to add one pole to the calculated requirement. The model's designers must change the algorithm.

Serving Area Interface

The Hatfield Model uses a single SAI per CBG regardless of the number of lines served by the SAI. This results in a SAI serving as many as 35,000 lines. Again, this is not possible. Proper design requires that the 35,000 lines be assigned across multiple SAIs. The Hatfield Model has not done that. Costs for additional SAIs are missing from the Hatfield Model results.

Switch

The Hatfield Model does not appear to support proper host/remote switching designs. We base this statement in large on the cost data used within the model. Although the model suggests the use of remote terminals, the only cost data provided appear to be derived from I central office "per-line" costs. We recommend an evaluation of the data and clarification of this issue.

The switch room sizes seem unrealistic. The values used appear to equate to 2,000 square feet per 10,000 lines for a 50,000 line switch, which is larger than normal and not compatible with the 5,000 lines value. Also, it is unclear if all associated costs for ancillary equipment are included in the costs for smaller line count switches.

The 25,000 line and 50,000 line switch sites are major site builds. The costs used do not reflect the substantially higher construction costs associated with such a build. The Hatfield Model appears to reflect the costs associated with small room or small site switches and to exclude costs for power and similar ancillary equipment.

Terrain

The Hatfield Model makes no provision for the impact of groundwater on the cost of cable placement as a simple cost multiplier.

While the model recognizes the impact of hard rock, it only adjusts the input value if the bedrock is within one foot of the surface. Moreover, the model assigns no cost multiplier for any amount of soft rock, at any depth. These assumptions totally understate the real cost of placing facilities.

The Hatfield Model claims it is easier to go around difficult terrain than to go through it. They simply add 20 percent more cable. This is an unreasonable assertion. Utilities must follow right of ways or utilities easements that typically follow property lines, highways, or similar features and do not meander haphazardly wherever the ground looks soft and inexpensive.

Materials

Cables

Copper cable costs are not well documented or easily interpreted in the Hatfield Model. It does appear clear, however, that the costs used in the Hatfield Model do not include labor costs. The costs do not reflect the difference in price to place and splice cable in the distribution system versus the feeder system. However, if the costs are just for the materials and taxes, the cost appears to be extremely high.

The cost of fiber cable should be different depending on the method of placement (underground, aerial, or buried). Factors such as the composition of the cable, external sheath type, and the type of internal strength member contribute to these differences. In addition, current engineering practice may dictate use of extruded duct for buried cable (for example, Tamaqua duct). Self-supporting aerial cable would be more expensive than normal cable. Also, it is not clear if the costs for aerial cable include the cost of Kevlar (or similar) strand, to maintain a fully dielectric system. The system should recognize the fundamental differences in fiber cable costs in its default values and be easily modifiable.

Poles

The prices for poles quoted throughout the Hatfield Model are appropriate only for 30 foot, class 6 wood poles. The model assumes a pole cost of $450. This cost is too low, and the pole too small, to sustain another assumption of the model: that there are 2 other utilities attached to the pole. The telephone company would need to place a 40 foot, class 4 pole, at a cost of $693, to accommodate secondary power. The telephone company would need to place a 45 foot, class 4 pole, at a cost of $765, to accommodate primary and secondary power. If this is true, the level of structure sharing specified in the Hatfield Model would be impossible.